

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10025651

Project Registration

Project Title

EN-twin-e

Project Reference Number

10025651

Project Licensee(s)

SP Energy Networks Transmission

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

Michael Eves

Project Budget

£161,043.00

Project Summary

Greater real-time visibility of our transmission and distribution networks creates value for ourselves, NGESO, service providers, and ultimately the energy consumers who pay for the services required to balance the transmission system. During our discovery project we will determine the minimum viable product with NGESO as a primary user and with our technology and academic partners we will explore the art of the possible and then set out how we aim to achieve, and validate, our big idea to develop a digital twin that spans transmission and distribution.

The objectives for our discovery project are:

1. Establish the minimum viable product and the highest value use cases.
2. Determine the art of the possible based on available technology and data availability,
3. Outline an architecture for an interoperable digital twin considering best practice,
4. Develop a strategy to verify accuracy of our digital twin.

Project partners:

SPEN

- SPT (Lead) is the transmission network operator for central and southern Scotland and will be the lead organisation responsible for the delivery of the discovery phase. SPT will provide overall project management and governance as well as contributing to each of the work packages.
- SPD is the distribution network operator for central and southern Scotland, which is the predominant adjoining distribution network to SPT and therefore a key contributor and stakeholder to the digital twin. SPD will contribute information on existing and future digital systems that will contribute to the digital twin.

NGESO

- NGESO along with SPEN will be a user of the digital twin and will be critical in ensuring the interoperability and repeatability of the solution across all transmission and distribution networks. Within the discovery phase NGESO will contribute to the requirements gathering work package to help define the digital twin MVP.

University of Strathclyde (UoS)

- UoS conducts extensive research council, European Commission and industry- funded research, all closely related to the proposed work. UoS will lead the activities associated with the development of required specifications for the network digital twin to meet the system balancing requirements and conduct comprehensive testing and validation of the network digital twin for the targeted application.

Digital Catapult

- Digital Catapult, the UK's leading advanced digital technology R&D centre, will perform the integration role across the consortium partners, coordinating between academic experimentation and industrial roll out. The Digital Catapult will lead the Data and Architecture work package.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

This project has the potential to develop a standard approach to Digital Twins for power systems that can be rolled out across the UK enabling access to the £17bn whole system flexibility market.

The problem our innovation is aiming to solve is the absence of visualisation and simulation of the electricity transmission and distribution networks as a complete system in real-time. This absence leads to an inability to determine the full impacts and efficacy of using distribution connected assets to balance the national energy transmission system (NETS).

Balancing the NETS today is primarily achieved by instructing large generation assets connected to the transmission network to flex their output to follow demand. The growth in intermittent renewable generation connected to the transmission system required to achieve net zero is going to diminish the overall flexibility of the large generation assets connected at transmission. However, the electrification of heat and transport is a major component of the UK's strategy to achieve net zero targets. Due to the energy storage capability of electric heating and transportation this will increase the flexibility on the demand side. In addition, we are still seeing the continued proliferation of other distributed energy resources such as solar panels and wind turbines as well as standalone batteries, i.e. not as part of an electric vehicle.

To achieve net-zero and balance the NETS, the amount of transmission system balancing services provided by assets connected to distribution networks needs to grow significantly. NGESO's wider access programme is paving the way for this to happen from a markets perspective. This is very positive for consumers as they have more opportunity to participate in these markets and it is also beneficial to the operations of the markets themselves to have more choice of who can provide a service.

To continue this trajectory safely and securely and realise the benefits to consumers, the energy system and network (T+D) operators need full visibility of how using distribution connected assets to balance the NETS is going to impact their respective operations. There is an opportunity for SP Energy Networks as a Transmission and Distribution network operator to take on the challenge of providing an innovative solution that delivers this visibility by developing an open and interoperable digital twin of our transmission and distribution networks. SP Transmission is perfectly placed to coordinate this programme with a history of working collaboratively with NGESO, SPD and wider 3rd parties.

Project Approaches And Desired Outcomes

The Big Idea

A digital twin is a virtual representation of a physical object or system that is continuously updated from real-time data and uses simulation and AI to support decision making. Our big idea is to develop a digital twin that spans the transmission and distribution system and can be used to provide a service to NGENSO that will aid in decision making when choosing which distributed energy resources to use when balancing the NETS. Having this more complete view of the transmission and distribution networks will ensure the expected response is received at transmission without adversely impacting distribution.

We aim to provide NGENSO with the capability to run what-if scenarios using the digital twin. The results of these what-if scenarios can be used by SPT and the NGENSO to better inform decision making or to run further analysis or optimisation routines when selecting which bids and offers to accept or the expected response to, for example, frequency events.

As the observability of the network diminishes at lower voltage levels, we will explore the use of Artificial Intelligence to fill in gaps we have in our data and in some cases generate AI models of low voltage network operation where traditional methods of power system modelling and simulation are not possible or do not meet criteria, e.g. speed of convergence. This will require a novel approach to stitching the different data and models together, not just AI based and physics-based models but also correctly representing the interactions between the different voltage levels and electricity networks.

A digital twin of this nature provides a next generation digital service offered by SPT and SPD to NGENSO and to each other, the benefits of which span distribution, transmission, energy markets and the GB consumer. As a standalone innovation it will benefit consumers by accelerating DER participation in balancing services but due to its wider applicability it will also be an enabler to accelerate progress in other challenge areas, particularly Whole Systems. Digital Twins by their nature improve access to data and insights, but specifically this idea focuses this on improving the efficiency, security and resilience of the NETS by ensuring DER can safely deliver balancing services.

This idea incorporates:

- Working in the open and utilising open-source approaches,
- Facilitating the flow of data within and between organisations,
- Improving the visibility of infrastructure and assets, and
- Novel uses of data and digital platforms.

Innovation Justification

The application of a digital twin for the proposed application is a unique area that has not been explored comprehensively worldwide. We estimate the use of digital twins for this application to be at TRL level of 4, which is why it can't be considered business as usual. This project aligns well and complements the Digitalisation Strategy of National Grid ESO where the use of Digital Twin technology is envisioned to develop new balancing and control tools as well as with the National Digital Twin Programme run by the Centre for Digital Built Britain. Similarly, the project aligns well with a very recent Research Briefing of the UK Parliament on "Energy sector digitalisation". We will endeavour to engage with relevant stakeholders in our appendix to leverage their knowledge.

The application of similar technology for the power industry has been actively investigated in innovation projects both in the UK and internationally. For example, the Envision project by UKPN, the Low Carbon Technologies Detection project by WPD, and the "AI-Powered Digital Twin for the Power System" project funded by Innovate UK are investigating the development of DTs, however focusing more on the distribution network rather than on interactions with the transmission network or on operational timescales that will allow informing balancing services as the proposed project aims to do through unique placement in collaboration with the ESO and a TO. Further details can be found in Appendix 1.

Unlike a normal network model, the proposed network digital twin will be capable of live simulation of the distribution network in operational time and information exchange between the physical system and the twin, which to the extent proposed is highly novel. The innovation focus of the proposal is to enable increased visibility and simulation capability at operational time scales (close to real time)

of medium voltage (MV) and down to low voltage (LV) distribution networks. This will enable not only increased visibility of network operational limits within distribution networks but also to communicate DER availability and potential constraints to the system operator. This will in turn enable the ESO to carry out what-if scenarios and take balancing actions more effectively and ensure the services can be delivered from resources within the distribution networks.

In addition, once the digital twin and its capabilities are defined, further applications that it enables will be explored. For example, reinforcement prioritisation, co-simulation of transmission-distribution networks or equivalent network model development for use in transmission level studies.

Project Plans And Milestones

Project Plan And Milestones

Each work package is led by a different partner and can run in parallel to de-risk the delivery. Our outputs will inform the design of a prototype when we commence the Alpha phase.

We will work in an agile manner in a priority such that we prioritise the highest value outcome - which is the knowledge required to scope an alpha project and determine its feasibility. This will be demonstrated as we will ensure all data is transported and validated prior to project commencement so to ensure success.

Work Package 1: Defining the Requirements (SPT lead):

In order to establish what the ESO requirements are, we will:

- Capture the needs case for NETS balancing with respect to visibility of networks by running workshops with the Subject Matter Experts which will be captured as a functional specification
- Prioritise potential use cases based on value metrics that will include benefits to the consumer, markets and net-zero targets.

As a milestone, we will produce a functional specification for the minimum viable product that will inform the alpha and beta phases.

Work Package 2: Data and Architecture (Digital Catapult lead):

To identify what components of a generic Digital Twin architecture we currently possess, we will:

- Data Discovery: Ascertain the extent to which network data is available now through existing data feeds and future planned data feeds, then identify gaps and methods to fill those gaps in future phases.
- Architecture Definition: Outline architecture for digital twin considering general best practice for implementing open standards, maintaining cyber security and data privacy where appropriate.

This will result in a report of the current status and recommended solutions in order to provide a Digital Twin in Beta phase.

Work Package 3: DT specification and verification strategy (University of Strathclyde lead):

In order to identify the specific nuances that will be required to realise a Power Systems Digital Twin (over and above a generic DT), we will:

- Review the state of the art Digital Twins and their applications on power systems, identifying key projects, use cases and best practices.
- Specify key functionalities/requirements of the network DT (interaction with WS1 in terms of understanding ESO needs and WS2 in terms of understanding data availability).
- Develop a strategy to verify accuracy of the modelling using example areas of network with high enough observability.

The outcome will be a report which establishes the key requirements for a Power System specific Digital Twin.

Route To Market

Once Beta is completed, we see the Digital Twin becoming a Business as Usual entity as follows:

- As we will look to use existing platforms, we will identify and partner with the platform which aligns best with our MVP and best practices identified. We would expect that this entity would then act to supply the Digital Twin platform. We will ensure that the specifications, learning and identified gaps between different vendor platforms are made clear to enable interoperability and a competitive market that the platform can be procured from; in addition, we will ensure the relevant foreground IP is disseminated to facilitate this market.
- As a utility, we would expect to continue to invest in our network monitoring through our price control budgets to enable the minimum visibility required to inform the Digital Twin platform. We would also seek to work with iDN0s to inform them of the

requirements.

- We would develop a working group, reporting the Energy Networks Association Digital Workforce, to foster the continual evolution of the Digital Twin as the market continues to evolve towards Net Zero and maximise the impact of this project.
- Following the successful deployment of a sample network, we will then accelerate the rollout of the monitoring and follow up with rolling out the Digital Twin to cover our full network (in collaboration with SPD and the ESO).
- The largest barrier to realisation that we anticipate will be enabling the network visibility to enable to the platform and establishing sufficient communications with the ESO to enable the operational time window decision making; we would utilise the SIF to mitigate this.
- We do not see any regulatory impact from our proposal, as the data communications (while sensitive in nature) will be captured within our current IT and OT data policies, meaning that they will be used, communicated and stored in an appropriately secure manner with sufficient cyber security.
- The additional value in this platform will be the potential to provide an invaluable service to 3rd parties also – during the project, we will identify and explore use cases to support this uptake.
- We will also look to elevate the MVP developed in Beta further by integrating additional functionality based upon the value proposition it offers to the networks and consumer.

Costs

Total Project Costs

161043

SIF Funding

108239

This project has been approved by a senior member of staff

Yes